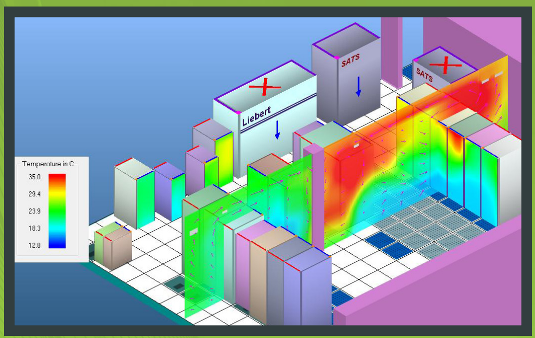
ENERGYLOK®
Case Study

“During the past five years, the power demands of equipment have grown significantly, imposing enormous pressures on the capacity of data centers... We recommend that data center executives focus short term on cooling, airflow and equipment placement to optimize their data center space”

Gartner Report
January 31, 2012



CFD Modeling of Existing Conditions

upsite technologies®

Customer:
US based, Fortune 50 corporation with over 100 years of doing business in the information-handling field

Data Center Details:
One data center at 6996 ft^2

Needs:
The computer room contained 170 cabinets drawing an estimated total of 300 kW of power for an average cabinet density of 1.8 kW. Client believed they were providing the optimum intake-air conditions for the IT equipment in their computer room, and did not seem to have any problems, yet wanted to identify if substantial savings were available should they implement airflow management best practices to optimize their data center.

Results:
- Achieved annual energy savings of $27,000 (annually reaccuring).
- Reduced bypass airflow by 60% eliminating all occurrences of hotspots.
- Increased efficiency allowing reduction in server fan load and turning off of 2 cooling units.
- Improved system reliability generating an additional annual maintenance savings of $6000.
- Realized full return on investment ($26,000) in first year.

ENERGYLOK®
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Global Leader Realized Financial Impact with EnergyLok Profile

An American multinational technology and consulting corporation founded in 1911 the client manufactures and sells computer hardware and software, and it offers infrastructure, hosting and consulting services in areas ranging from mainframe computers to nanotechnology. As one of the largest publicly traded technology company in the world by market capitalization, Fortune ranks among the largest most profitable firms in the US Globally, the company has been ranked in the top 50 largest firms by Forbes.

Data Center Needs

This US based technology company hosts a team of over 426,751 employees serving clients in over 170 countries, with occupations including scientists, engineers, consultants, and sales professionals. Their corporate commitment to developing and delivering best practices is widely known and evidenced by their online resources about best practices associated with their products. When challenged to increase their facilities capacity, they logically began the process of evaluating their data center to industry established best practices for optimization.

Upsite Technologies and The Uptime Institute had conducted a comprehensive survey of actual cooling conditions in 19 computer rooms totaling 204,400 ft^2 of raised floor space to produce the study*. It was found that 10% of the racks had intake air temperatures of 75˚F or higher at the top of the rack, a prime condition for cool air not being managed effectively.

Hotspots were shown to decrease server reliability and even cause malfunctions or outright failures, causing unnecessary downtime. The same study also showed that 60% of the available supply of cooled air is short-cycling back to the cooling units without ever passing through IT equipment – a phenomenon known as bypass airflow.

Solution

The computer room cooling health improvements and financial impact of engaging EnergyLok are proven in the before remediation and after remediation conditions of a 6996 ft2 client data center. To determine what improvements were possible, Upsite staff performed an EnergyLok™, multi-hour computer room cooling efficiency health check designed to examine the fundamentals of computer room health, and provide recommendations for improvement. During the check, measurements were taken of bypass airflow and hotspots (cabinet intake-air temperatures which exceed established maximums), and data was collected to calculate the current cooling capacity factor (CCF) the ratio of installed capacity to the critical load.

See Chart below for specific data

Because the client followed EnergyLok recommendations and remediation strategy, all hotspots were eliminated and there was a 60% improvement in bypass airflow. This meant that the reliability of the IT equipment improved. In addition, because of improvements to airflow management, the client was able to turn off 2 cooling units, placing them in inactive standby mode.

The client reported a utility load reduction of 30 kW from following the remediation strategy. The primary contributing elements to the utility load reduction are: 2 fewer fan motors running, increased cooling unit efficiency, and decreased server fan load.

A conservative value of a 25 kW reduction will be used for cost savings and CO_2 reduction throughout this study. A 25 kW load reduction represents a cost savings of $21,900/year ($1,825/month), assuming $0.10/kWh, and CO2 reduction of 193 tons/year (16 tons/month), assuming black coal generation.

Aspect of Cooling Health	Recommended Conditions	BEFORE EnergyLok	AFTER EnergyLok
Bypass Airflow	**≤ 10%**	**86%**	**34%** (60% improvement)
Hotspots	**None**	**4%** (7 cabinets)	**None** (100% improvement)
Cooling Capacity Factor	**~ 1.2 x load**	**2.2 x load**	**1.7 x load**

Before and After EnergyLok Remediation Strategy

The EnergyLok service (1) uncovered the existing conditions to provide a cooling health benchmark, (2) delivered recommended solutions, (3) and returned after improvements had been made to document the results. (Note: Some information was measured by Upsite and some was provided by the client.)

1 Measured and counted openings in the raised floor to estimate the percentage of bypass airflow:

Before EnergyLok Solution: 102 perforated floor tiles were counted, 89 (87%) of which were properly located. The numerous unsealed cable openings and misplaced perforated tiles caused an estimated 86% bypass airflow.

Recommended EnergyLok Solution: Seal all cable openings with effective seals, such as KoldLok® Raised Floor Grommets. Replace perforated tiles in hot aisles and inactive areas with solid tiles. Provided specific instructions that indicated how to adjust the number and type of perforated tiles to achieve the most efficient delivery of conditioned air without exceeding the maximum allowable IT equipment intake temperature (75.2˚F in the case of this client).

After EnergyLok Solution: The majority of cable openings were sealed, so that 34% of the conditioned air flow is coming out of unsealed cable openings, a 60% improvement. The number of perforated floor tiles was reduced to 96 and all are now properly located.

2 Measured IT equipment intake-air temperatures to determine the percentage of IT equipment cabinets with hotspots :

IT equipment intake temperatures of ≥ 77˚F, the maximum allowable temperature established by the client. To achieve maximum cooling capacity efficiency, Upsite recommends following the ASHRAE recommendation of 80.6˚F

Before EnergyLok Solution: 7 of the 170 cabinets (4%) have intake-air temperatures ≥ 77˚F, the threshold for a hotspot. The relative humidity (Rh) at these 7 locations was measured at 35 to 40%.

Recommended EnergyLok Solution: Monitor temperature and relative humidity. This is especially important for servers in the top-third of cabinets and where hotspots have been identified—temperatures ≥ 77˚F—and/or where relative humidity is less than 30%. Identifying and monitoring room conditions is the first step in effective management.

After EnergyLok Solution: None of the 151 cabinets contain IT equipment with intake-air temperatures above the ≥ 77˚F threshold for a hotspot. The Rh at several locations was above 40%.

3 Recorded the reported power consumption of computing equipment in kilowatts:

Before EnergyLok Solution: The computer room contained 170 cabinets drawing an estimated reported total of 300 kW of power for an average cabinet density of 1.8 kW

Recommended EnergyLok Solution: There is no recommendation to be made on total power load.

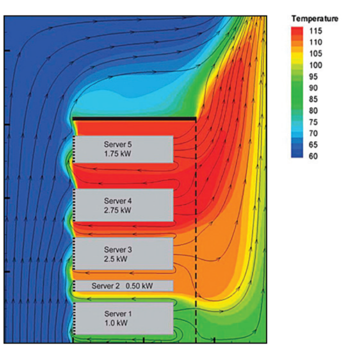
After EnergyLok Solution: The computer room contained 151 cabinets drawing a reported total of 310 kW of power for an average cabinet density of 2.1 kW.

4 Examined the open areas in cabinets to understand hotspot prevalence:

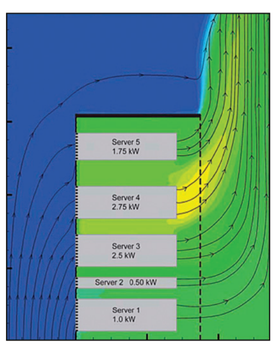
Before EnergyLok Solution: There are extensive open areas within the 170 cabinets, allowing hot exhaust air to circulate from the back of equipment to the front where it is drawn in by IT equipment.

Recommended EnergyLok Solution: Fill all open areas within the cabinets with blanking panels, such as HotLok® Blanking Panels.

After EnergyLok Solution: A reported 95% of the open areas within the 151 IT cabinets have been filled with blanking panels. Fill the remaining 5% of the original open areas within the active cabinets with blanking panels to reduce in-cabinet circulation of exhaust airflow, and therefore improve IT equipment reliability and cooling system efficiency. Also seal any open areas at the front of each cabinet between the equipment mounting rails and the cabinet side panels.



Cross Section of Airflow in a server cabinet without blanking panels installed



Cross Section of Airflow in a server cabinet with no horizontal air gaps between adjacent panels or servers

5 Measured the static pressure of the raised-floor plenum to assess the presence of underfloor air dams, cooling unit functionality, and effect of bypass airflow:

Before EnergyLok Solution: Relatively high static pressure is the result of cooling units with a total 2.2 times the required cooling capacity running in the room, and secondarily from perforated tiles with low percent open area.

Recommended EnergyLok Solution: Reduce bypass airflow by sealing all cable openings with effective seals, adjust the number, placement, and type of perforated tiles, and then turn off up to 2 cooling units. (Note: Specific instructions were provided as to the correct sequencing of remediation measures. If the appropriate sequence is not followed and IT equipment intake conditions are not carefully monitored, then IT equipment can be damaged by overheating.)

After EnergyLok Solution: The static pressure in the room remained high even with 2 cooling units turned off. This is the result of airflow management best practices being implemented.

6 Summed cooling unit rated cooling capacity in kW and calculation of CCF:

Before EnergyLok Solution: 8 cooling units rated at 70 kW each, plus 1 unit rated at 85 kW, providing a total rated capacity of 645 kW of cooling. With a critical load of 300 kW, the CCF is 2.2 (645 kW/300 kW = 2.2).

Recommended EnergyLok Solution: After all adjustments are made, it may be possible to place 2 of the cooling units in inactive standby. If this is attempted, careful monitoring of the IT equipment intake-air temperatures is necessary to prevent equipment damage and downtime. Have all the cooling units tested to determine if they are providing their rated cooling and airflow capacity and that temperature and relative humidity sensors are calibrated. (Please note: EnergyLok delivers other diagnostic services that perform these measurements.)

After EnergyLok Solution: Two of the 70 kW units were turned off, resulting in 505 kW of running cooling capacity. With an After conditions critical load of 310kW, the resulting CCF is 1.6 (505 kW/310 kW = 1.6). A CCF of 1.6 is much more reasonable and represents a more efficient configuration with 60% over, or redundant, cooling capacity compared to the 120% over-capacity calculated for the Before state. A CCF of 1.2, or 20% redundant capacity, is a useful guideline in determining the appropriate amount of excess cooling to have running, as long as there is always at least one redundant cooling unit per area in the room.

Annual Operating Cost Savings

Cost savings resulted from energy saved by turning off fan motors of 2 large cooling units, decreased server fan load, and from the increased efficiency of the remaining cooling units. Reduced server fan load is the result of server fans slowing down when air-intake temperatures decrease.

The improvements in efficiency of the remaining operational cooling units were the result of higher return-air temperatures. At higher return-air temperatures, cooling units have greater capacity and efficiency. The higher return-air temperatures were the result of reducing the mixing of condi-tioned and return air by sealing bypass openings.

Reported utility load reduction resulting from following recommendations is 30 kW. A conservative value of 25 kW will be used for all calculations.

- **Monthly kWhr savings** = 18,250 kWhrs
  (25 kW x 730 hrs/mo = 18,250 kWhrs/mo)
- **Annual kWhr savings** = 219,000 kWhrs
  (25 kW x 24 hrs x 365 days = 219.000 kWhrs/yr)
- **Monthly cost savings** (at $0.10/kWh) = $1,825/mo
  (18,250 kWhrs x $0.10/kWh = $1,825/mo)
- **Annual cost savings** (at $0.10/kWh) = $21,900/yr
  (219,000 kWhrs x $0.10/kWh = $21,900/yr)

Annual maintenance savings per unit are approximately $3,000

Total annual maintenance cost savings = $6,000
($3,000 x 2 units = $6,000)

Total annual savings = $27,900
($21,900 + $6,000 = $27,900)

Total monthly savings = $2,325

Simple Payback Analysis

Simple payback calculations are based on: monthly savings of $2,325 and a total KoldLok and HotLok product cost of $26,000, incurred once in the first month. Cost savings are realized immediately upon completion of installation and continue indefinitely. Simple payback occurs between the eleventh and twelfth months, with a total net savings of $1,901 in the first year and approximately $28,000 each year thereafter.

Simple Payback Analysis	
Month	$ Savings
1	-23,674
2	-21,349
3	-19,024
4	-16,699
5	-14,374
6	-12,049
7	-9,724
8	-7,399
9	-5,074
10	-2,749
11	-424
12	+1,901

Simple Payback by Month

The kWhr reduction at client site is 219,000 kWhrs/yr. Depending on the type of fuel used to generate electricity, this equates to an annual CO2 reduction of:

- Natural gas generation: 109 tons
- Oil generation: 121 tons
- Black coal: 193 tons
- Brown coal: 290 tons

The above calculations are based on the following approximate pounds of CO2 released per kWh of electricity generated at fossil-fuelled power stations:

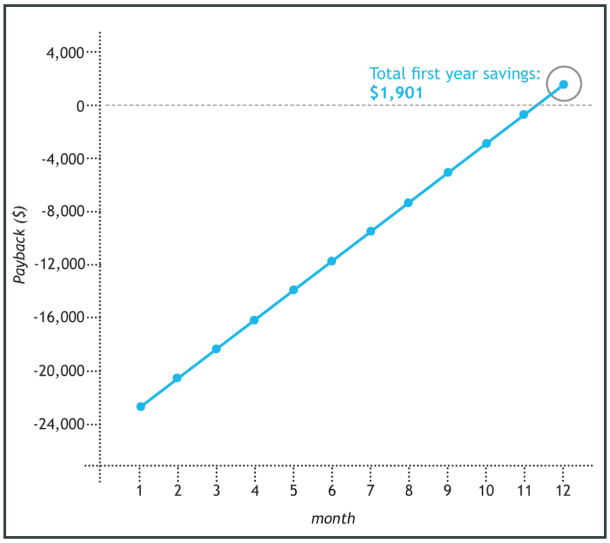
- Natural gas generation = 1 pound
- Oil generation = 1.1 pounds
- Black coal generation = 1.8 pounds
- Brown coal generation = 2.6 pounds

Conclusion

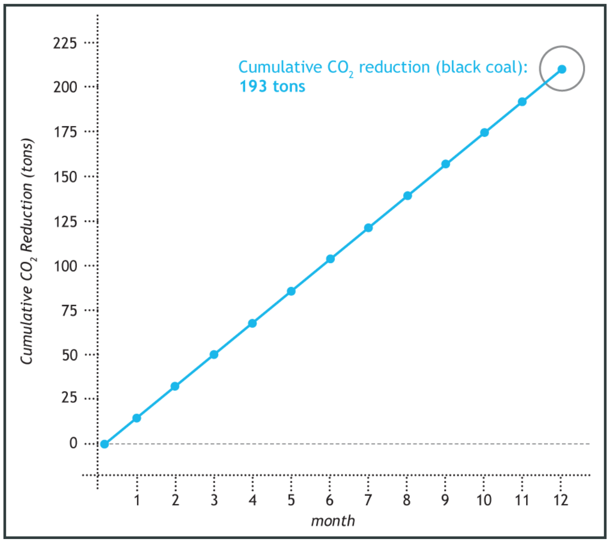
Even if you are providing optimum intake-air conditions for the IT equipment in your computer room, and you don't seem to have any problems, there may be substantial savings available to you. The first step in recovering stranded capacity is to understand how the airflow and cooling dynamics of your data center are causing energy waste. Then you can employ Upsite's best practice products to optimize your data center. This case study underscores the importance of the role of Upsite Technologies products and services play in the life of your data center and your business.

By engaging EnergyLok Services, you can expect expert computer room remediation strategies that can be implemented immediately for near-instant reduction in operating expense, rapid return, significant CO2 reduction, and the ability to reliably cool increased server density.

Simple Payback Analysis



CO^2 Reduction



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